

Woodworking and Joinery: A Deeper Understanding of Architecture

An Honors Thesis (HONR 499)

by

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Abstract

As a discipline, architecture concerns itself with creativity and innovation within the practice of design. The process of design, which is inherently recursive, allows architects to jump between designing, investigating, and discovering in order to realize a design that truly pushes the boundaries of its purpose. My creative thesis project, which engages in this process of recursive design, took on the challenge of creating an innovative design solution for a simple chair. Material investigation and joinery techniques provide further immense opportunities for problem solving in the architectural discipline, specifically as it relates to furniture design. Endless possibilities evolve from materiality choices; however, I chose to investigate the properties of wood as a material and its ability to join together structurally and aesthetically. However, my creative thesis project is not simply a chair. It is a journey to discovering the personal evolution of a designer as he or she engages with design and seeks to transform raw material into pure beauty.

Acknowledgements

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I would also like to thank Roger Whitted, the Design Build Lab Shop Attendant, for his additional knowledge on furniture design and what tools in the Design Build Lab would be best suited for my needs. It was with his careful attention to detail and extreme patience that I grew in both my understanding of fabrication tools and my meticulous eye for woodworking.

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Woodworking and Joinery: A Deeper Understanding of Architecture

Architecture as a discipline concerns itself with creativity and innovation in the practice of design. Innovative design, unbuilt or built, is achieved when an integration of aesthetics, function, and utility is found. Throughout the architectural discipline, designers seek to achieve this innovation in their ideas. Whether working on conceptual project ideas in academia or building a project in the profession, good design requires creative endeavor and careful articulation. The recursive design process allows architects to jump between designing, investigating, and discovering in order to realize a design that truly pushes the boundaries of its purpose. My creative thesis project, engaging the process of designing, investigating, and discovering, hoped to achieve an innovative design solution. Inspired by the idea of scaling the architectural design process down to furniture design, I chose to look at woodworking and fabrication techniques to design an innovative chair.

In the process of determining the initial ideas and processes for my thesis project, I decided upon six different learning goals to accomplish along the journey:

1. **Material Study and Investigation** - Material investigations provide immense opportunities for problem solving in the architectural discipline. Furniture design in particular has a serious interest in understanding how materials can directly influence and shape the design process. I chose to investigate the properties of wood as a material and its ability to join together structurally and aesthetically. By studying the properties of wood and gaining a better understanding of how it behaves under certain conditions, I could use the research to determine the best design for a wood furniture piece.

2. **Joinery Study and Investigation** – Woodworking offers a multitude of opportunities to create joints. Wherever material intersections occur, a joint must take place. Throughout time a number of different joinery techniques and technologies have been created to hold wood together in structural and aesthetic ways. Similarly, architecture is comprised of joints and intersections between materials. The joints that occur in architecture are for structural and aesthetic purposes as well as to keep water out of the building. By studying joinery techniques in woodworking, I hoped to gain a much better understanding of how materials can come together in architectural design.
3. **Woodworking Tools and Processes** - The tools, both analogue and digital which are used to design and fabricate wood furniture pieces also have an impact on the design process. Analogue tools, those associated with hand and eye coordination as well as some tooling precision allows for a loose and less calculated workmanship. Often times, designers create jigs that make it easier and more precise to machine a material in a particular way. Digital tools on the other hand usually force calculated precision that can create mastery in craftsmanship. In my thesis, I studied how wood can be created and joined together using the various analogue and digital tools we have available.
4. **Workmanship of Risk and Craftsmanship** – Using different tools, analogue and digital to aid in the process of woodworking can determine the amount of risk involved in such a task. The more the woodworker relies on direct hand and eye coordination in making a cut, the more risk is involved in performing

that task. On the other hand, if a woodworker relies on jigs or precision digital tooling, the result is pre-determined and the risk factor is quite low. Today, most furniture is mass produced in a factory where the precise machines produce equally perfect parts each time. To some, pure craftsmanship “depends on the judgement, dexterity, and care which the maker exercises as he works” (Pye, 1978). In my thesis project, I sought to understand this relationship between workmanship and risk.

5. **Complexity and Simplicity** – Design can take on many shapes and forms.

Sometimes good design is determined by the visual complexity of those shapes and forms, and the difficulty in fabricating those geometries. However, good design can also appear very simple, yet have a loaded complexity not seen by the naked eye. My goal in this thesis project was to create a piece of furniture that appears very simple and regular to the naked eye but yet is very complex in the woodworking and joinery.

I set off on my journey through my senior honors thesis by examining well-known furniture makers to better understand their work and their processes in hopes of discovering something that would inspire my project. Josh Coggeshall, my thesis advisor, helped point me in the direction of some of the most famous furniture designers and their philosophies on design. Among those designers were woodworkers and architects.

David Pye, a professor of furniture design at The Royal College of Art from 1964 to 1974 inspired my interest in craftsmanship and the risks involved in working with your

hands. Upon reading a few pages from his book, "The Nature and Art of Workmanship," I learned a significant amount about good design in woodworking and how that relates to craftsmanship. According to Pye, "Good material is a myth." He remarks that "Material in the raw is nothing much. Only worked material has quality, and pieces of worked material are made to show their quality by men, or put together so that together they show a quality which singly they had not" (Pye, 1978). Here it is evident that Pye holds a particular importance to that act of "man-made" products. Only in the hands of a designer/craftsman can a material turn in to something useful. Pye also goes on to say that "It is only because of workmanlike felling and converting and drying and selection, and machining and setting out and cutting and fitting and assembly and finishing – particularly finishing – that a very small proportion of the tree comes to be thought of as good material" (Pye, 1978). In this passage, Pye inspired me to understand wood in all the ways described above. This opportunity to study every aspect of wood would be the process I would need to take to achieve a piece of craftsmanship.

Sam Maloof, the second furniture designer and woodworker who I researched, was the first craftsman to receive a MacArthur Fellowship. Some of his custom work is currently being displayed in major American museums. His beautiful, precise, flawless, furniture is all hand crafted. Although Maloof created jigs and used modern tools to create his pieces, most of his work was done with the judgement and care of his own eye. Best known for his chair leg to seat joinery, Maloof had perfected the strongest, articulated, and expressive joint for any wooden furniture. Inspired by the flawlessness in his careful handling and machining of wood and the design of his woodwork joinery, I

found a particular interest in designing and creating joints that are expressive and structural.



Coy Howard, architect, professor, and furniture maker is an example of an architect using furniture design and woodworking as a way to investigate architectural ideologies on a smaller scale. Howard's interest in artistic "making" has led him to many awards for design excellence and to his furniture designs being placed in many permanent design collections. His particular chair which interests me the most is one in which careful articulation of surface pattern and texture indicated places to pick the chair up from the ground and where to sit according to body contours. Sleek precision upholds this piece of craftsmanship as one that has achieved design and fabrication excellence.



Charles and Ray Eames are two other architects and designers who have found a special interest in exploring their design ideologies through the making of furniture. The couple may be best known for designing their own home and studio which “is considered one of the most important post-war residences anywhere in the world” (“Eames Office”, 2013). Their furniture design and fabrication is also well known throughout the design world. Molded plywood chairs led their furniture design innovation in ways that the world had never seen before. Following the molded plywood work, the Eames fabricated furniture out of fiberglass, plastic resin, and wire mesh. Their designs were so ergonomic and well-liked that furniture manufacturer, Herman Miller began producing their work. While these fabrication materials and technologies fascinated my interests in other possibilities for furniture design, my lack of knowledge in producing fiberglass, plastic resin or wire mesh steered my thesis project away from these materials.



After researching numerous different designers and gaining a better understanding of some material choices and fabrication techniques for furniture design, I decided that wood was going to be my medium of choice. Understanding the

difference between hardwoods and softwoods, surprisingly not named upon their hardness factor, is the first step in picking a wood to investigate. Hardwoods, coming from deciduous trees have been historically used as furniture making materials because of their density, stability, beautiful colors, and tight grain patterns, among other factors. Plentiful in Indiana, hardwoods are local, sustainable resources that come in a variety of shapes, sizes, and colors. The most crucial factor to consider while using wood for furniture is its moisture content. Notorious for swelling when water logged and shrinking and cracking when dry, wood can be fickle. My investigation of wood moisture content concluded that I needed to find previously dried wood that would not crack after turning it into a piece of furniture. I traveled to Frank Miller Lumber, a saw mill near Muncie, to search for a dry wood that could become my piece of furniture. I bought seventeen board feet of kiln dried, quarter sawn white oak to use for my design because of its beautiful grain patterns. Upon traveling to yet another saw mill in Northern Indiana shortly after, I bought several more board feet of black walnut and white ash. Having purchased a variety of different types of hardwoods, I was able to begin the design process.

Thinking about all the different types and pieces of furniture that I could build, chairs and tables seemed to be the most commonly used and designed. In fact, most of the designers whom I researched are specifically noted for their chair designs. In the beginning, I set my hopes high, anticipating the opportunity to build both a chair and a table as a possible matching set. In starting to design this matching set, I questioned everything. What is the purpose of a chair and a table? What are the comfortability levels? Is the table meant as a working surface or a material holding surface only? Is it

rigid or fluid? Is it one type of wood or multiple types of wood? Ultimately, I had to determine a program for the pieces, as that would be the number one identifying move to the form.

Establishing “conversation” as the program of my furniture pieces, I began investigating the social dynamic of people and how furniture either improves or hinders that dynamic. I found that upright posture, physical distance, eye contact, and body language all play significant roles in conversation. Each of these conditions needed for good communication can be directly affected by the design of the furniture. Through sketching and using a computer software called Rhinoceros, I began designing ideas that encouraged upright posture, supported perfect physical distance, maneuvered for eye contact, and facilitated body language. The initial design for the chair included an adjustable backing, arm rests, and overall mobility. The initial design for the table on the other hand was placed at a height conducive to conversation with the size of the chair and provided ample space for the seating of two people. Mimicking the back and forth conversation of speaking and listening all stemming from a single question, the table appears as if it were a part of the conversation. The first study model is at 1/8” equals 1” which helped me realized the design potential of the pieces.



Upon reaching these conclusions and discussing them with my honors thesis advisor, I decided to look at redesigning parts of the chair. At this point in the design process, I decided to focus my full attention on the chair and discontinue work on the table. In one semester, I found that designing and fabricating all of the intricacies to one piece would keep me busy and fulfil my goals. The chair presented many design challenges. Proportion and ergonomics, the two most challenging aspects, required an immense amount of research. Chairs come in all different shapes and sizes, but a regular height dinning chair has very specific sizes that contribute toward comfortability. Roughly eighteen inches tall and sixteen inches wide, the chair had to be exact. Following my first study model, I continued to build digital models and physical models to help better understand these proportions and sizes. I quickly found that understanding scale and proportion on a digital software is much more difficult than building an actual full size model.





Once I determined the exact sizes for my chair to fit its purpose, I began to research joinery techniques. This, the most difficult part of the design process had two main goals, structural support and aesthetics. The point at which two different materials join together has the potential to be the weakest point or the strongest point. Joining two straight faces of wood together with glue can create a very weak joint as there is very

little material contact. To increase material contact and friction, wood joints are often inlaid and inset into one another so that the overall surface area making contact is greater. I was able to study this technique by thinking of opposite, positive and negative spaces or male/female spaces that can create a good strong connection. Glue, a must use in woodworking became an essential element to these joints. Lots of glue and material contact can make for a very strong joint that requires little more support. Although glue is a wonderful additive to strong connections, I also researched wood joinery using wood dowels, wood biscuits, and metal screws. Wooden dowels and biscuits are essentially the same thing and create a similar connection. Both methods require you to subtract material so that you can add material which ties two pieces of wood together. These joints can be so successful because they are hidden out of sight, adding to the aesthetics of the piece. In fact, careful thought had to go into the creation of the joints because of how they created relationships between the legs, seat, and back. Having similar joints brings an overall completeness and uniformity to a project.



Finally, after completing a long process of design and investigation, I came to an innovative solution that I was prepared to flesh out as the final product. The design, having a clear program and intention, comfort to the human body, and joints that are strong and attractive, was well prepared to be built. The fabrication process began by cleaning the wood that I bought and determining which woods I would use in certain locations. The black walnut and white ash boards, being contrasting colors and the same thickness of 1-3/8" were perfect to use together for my chair. My digital software allowed me to render my chair in the colors of the wood to determine the perfect board placement for the best looks. While I had hoped to use walnut for the entire seat and back and the white ash for the legs only, I did not have enough walnut purchased to yield the entire seat. Along the way I made the decision to use one strip of white ash in the seat as an accent color and as a way to achieve the full sixteen inches that was perfect for comfort. The boards that comprise the seat and back are extended the full length of the seat and the back to allow the grain pattern to flow continuously. While this was my intention in the design phases, it did not fully come to fruition until the fabrication stages.

Fabricating the seat and the back gave me the perfect opportunity to start researching and using the tools in the shop and the joinery techniques I have discussed previously. My seat and back are broken up into three pieces, each of which are a series of boards that are biscuit jointed, glued, and clamped for superior strength and alignment. The boards that comprise the outside of my seat are tapered so that overall, the seat is tapered from wide at the legs to skinning at the back. The back however, is not tapered but is rather the same width as the back of the seat. Each of the three

pieces, the seat and two back pieces, had to be fabricated separately so that I could cut them on the flat surface of the table saw. After being glued and clamped for over twenty-four hours apiece, they were ready to be sanded, cut and joined together.



At a unique angle, the back of the seat required some specialized cutting on the table saw. Thankfully, the table saw is a tool that can cut straight lines and precise angles depending on the accuracy of the measurements that I take. While this process is fairly precision based, it also requires a bit of hand, eye coordination and personally determined measurements. Removing excess wood from the seat with the table saw allows the back to connect precisely and accurately. However, before connecting the back to the seat, I had to prepare both to accept the legs into a joint. The seat had to be specifically notched on the table saw to allow for an inset where the front legs would connect. For a stronger connection I drilled holes in the seat to create a wooden dowel

joint. The back pieces also had to be notched and prepared for the back legs. Cutting wood out of the back pieces created an inset where the legs could join and connect on more surface area. Finally, all the steps were taken to biscuit and glue the two back pieces together. These two pieces, also on a tricky angle, required me to build a jig that would set the angle in place. Even though the two pieces were cut with the correct angle, they had to sit on the jig in a way that would allow me to clamp them so that there was little to no movement in the joint once glued.



After clamping the glued back piece together for over twenty-four hours, It was ready to be attached to the seat. This critical connection, joining the back to the seat, was the most important to fasten securely. While no biscuits or dowels were used on this connection, I did fasten them together with two screws and glue. Thankfully, my connection point for the two screws could be later hidden by the legs where they will never be seen again. The connection with the two screws was so tight that it did not have to be clamped; the glue was able to dry on its own.



Next, after finishing the seat and back, I had to prepare the legs. The front legs were rather easy. As uniform, square legs, I simply used the precision of the table saw to cut two of the exact same leg. But just when I thought it could not get any easier than that, I remembered that I had intended to taper the legs down from the seat to the floor on two of the sides. In order to do this, I had to build a specialized jig that would allow me to cut an angle on the table saw. Using scrap pieces of wood, I designed a simple wooden jig that held my leg at the appropriate angle which would allow me to make a straight cut on the table saw. After using the jig to cut two sides of each leg the last step was to prepare them for the dowel joint, connection to the seat. I used the same drill bit to drill these holes as I used on the seat so that the dowels would slide in perfectly and fit tightly.



Lastly and certainly the most difficult were the back legs. Required to hold the weight of a person and create a secure, strong connection between the back and the seat, the back legs had to be accurate. I decided that instead of breaking the back legs up into two separate pieces and potentially creating a weak connection, I would cut the angled legs out of one piece of wood. I used the precision of the computer model and drawings to draw out the shape of the legs on my slab of wood. Each coordinate from the computer pinpointed exactly where each angle would lie. Then, using a much less precise method, I used the open blade of a band saw to cut along each line. Without using any guides and only a straight vertical blade, I had to use my best judgement to cut straight lines. Any fluctuations and irregularities I created in the wood had to be sanded out with a heavy duty belt sander. Trial and error proved to be the only way to get these pieces correct. After being cut out on the band saw and sanded with the belt sander, I also had to use the table saw and chisels to notch the legs out to join with the back and the seat. While this process was also difficult to get accurate, it had much more precision than the band saw had. Unfortunately, with the round blade of the table saw, I could not cut the hard edges of the joint that I needed. By pushing the wood into

the blade far enough to make a cut but not too far to make an excess cut, I could almost make the entire joint. The wood that was still left in the joint from the table saw had to be removed with a chisel as there was no power tool to get the job done correctly. This process, the epitome of hand-eye coordination, finally made me realize the craftsmanship that I was putting into the chair. The long, arduous process of fabricating these legs took nearly twelve hours.

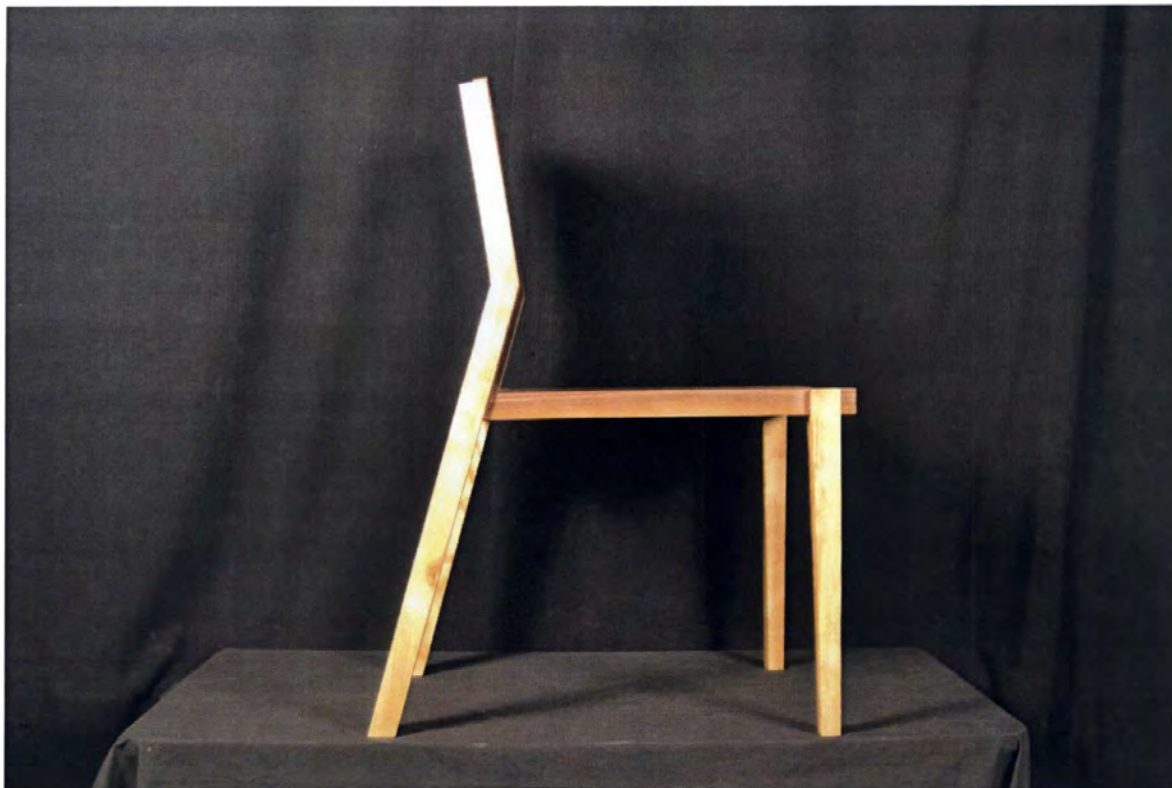
The home stretch to completing the chair was finally near. Each leg had to be progressively sanded, starting with coarse sandpaper and finishing with fine sandpaper. Each piece of sandpaper scratches the surface of the chair. The coarse sandpaper creates deep scratches and then the finer sandpaper creates shallow scratches that are barely noticeable. By the end of the sanding process, my wood was as smooth as some plastic surfaces. I proceeded by gluing and clamping the legs to the chair. The front legs were attached with wooden dowels whereas the back legs were simply glued into place. Accurate and strong clamp placement for over twenty-four hours ensured that the legs were adhered successfully and that there was no unwanted movement in the chair joints. After one last pass with the sandpaper to remove the excess glue, the chair was ready to finish.

To finish the chair, I chose to use Danish staining oil that would bring out the natural color of the wood as well as seal it. I began by wiping the unwanted dust off of the surface of the chair. Then I continued by applying the first coat of the Danish oil with a clean rag and buffing it out with a separate, dry, clean rag. Buffing out each coat of the Danish oil ensured that it was evenly distributed and that no oil started to run or drip. After the oil dried for six hours or more, I would sand the entire chair with very fine

sandpaper and then repeat the process with another coat. I followed these steps three times so that the chair had three even coats of oil. Overall, the three coats of oil really brought out a beautiful natural color in the wood and made the piece of furniture wonderful to sit on.

Designing, investigating, discovering, and fabricating this chair and work of art, taught me a lot about each of the goals I hoped to research and explore. My design solution appears simplistic at first glance, but understanding the processes, methods, and cuts that I had to make to fabricate the chair, shows that the piece is rather complex. The innovative design for the chair exhibits beautiful aesthetics, useful function, and strong utility. Overall, the design process taught me an immense amount about furniture design and how I can apply the same techniques and methods to architecture.







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